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WATER POLLUTION: EVERYBODY'S WAR

Water pollution has probably killed more people than all the wars in history. Despite the advances of medical science, millions still die every year from water-borne diseases. And every year, in Canada, water pollution costs us more than all the fires, floods, accidents and other disasters across the country.

Some of our lakes and rivers are so polluted that they menace health and stifle industrial growth. Fish die in our streams while scum and algae drive us from the beaches. Tourist resorts and other businesses fail, property values fall and taxes rise with the climbing cost of water treatment.

Unless we control this growing threat it could destroy our industries, our living standards and even our civilized way of life. Not only our towns and cities would suffer, but also the countryside and wilderness where we seek refreshment.

The war on water pollution is everybody's war. It involves all levels of government—federal, provincial and municipal—as well as private industry, universities, labor and professional groups, conservation and community associations. Along our boundaries it is an international war, with Canada and the United States allied against a common danger.

Directing the battle at the federal level is Canada's Department of Energy, Mines and Resources. Working closely with the provinces and other federal agencies, EMR carries on needed research in water pollution and advises the Government of Canada on water policy. Meanwhile it cooperates in the research efforts of universities and other organizations.

Faced with so serious a challenge, this department has a big and vital job to do.



WHAT IS POLLUTION?

Outside the laboratory no water is absolutely pure. Its purest natural form is fresh snow, but even snow contains dust particles. In raindrops we also find small amounts of dissolved oxygen, nitrogen and other atmospheric gases. After striking the earth water steadily picks up other impurities from rocks, soil and other sources.

Not all these impurities are undesirable, though. Fish would drown in absolutely pure water, because they need dissolved oxygen to breathe. Moreover, water distilled in a laboratory tastes unpleasantly flat. Consequently, we call water "polluted" only when its usefulness is impaired.

Water is polluted when we cannot safely drink it, wash with it or spray it on our crops. It is polluted when impurities make it unpleasant for swimming or boating, or unsuitable for use in our factories. Water is polluted whenever its taste, smell or color offends us—whenever these spoil it for our use or enjoyment.

With chlorination and other treatment, polluted water can often be rendered fit for human use. Sometimes, though, it may be so heavily polluted that effective treatment would be too costly. Also, by using badly contaminated water, a city

2 would risk disaster if its treatment system ever failed.

A MAN-MADE PROBLEM

Some pollution is of natural origin, like the calcium and magnesium salts in excessively hard water. Other examples are the mud that silts up our reservoirs and the sea water that seeps into some of our wells near the ocean. But our major battle is with man-made pollution.

Wherever towns and cities flourish, wherever industry prospers and modern agriculture thrives, there we contaminate our waterways with harmful or offensive wastes. This artificial pollution is one of the costs of our civilization, and to some degree may always be with us. But at least we must control it and keep it within safe, acceptable limits.

Water pollution has grown with our population and our industries. Scientific measurement of pollution is comparatively new, but even within a short time we can see the trend. The first official measurements in the Great Lakes system



were made in 1912; by 1950 bacterial concentrations in some parts of the system were three to four times higher. Moreover, industrial wastes—of small concern in 1912—had by 1950 become a major problem.

More recently a thick carpet of slimy green algae has appeared in the western part of Lake Erie. Its sudden appearance told of a long, steady build-up of chemical wastes which now serve as fertilizer for the algae. Other masses of these primitive aquatic plants point to similar contamination in lakes and streams across the country.

But pollution is not confined to inland waters. Along our Atlantic coasts some 20 to 25 per cent of the shellfish beds are contaminated by raw sewage. In the Gulf of St. Lawrence more than a quarter of the oyster beds are polluted. Less severely, sewage pollution has also struck at British Columbia oyster fisheries and swimming beaches.

AN ANCIENT ENEMY

Domestic sewage—principally garbage and human wastes—is the oldest source of man-made pollution. It swarms with bacteria and other microorganisms, some of them harmful and even deadly. In many countries, including Canada, sewage has been responsible for epidemics of cholera, typhoid fever and other killer diseases.

The standard indicator of sewage pollution is the presence of *Bacillus coli*, a rod-shaped bacterium found in the human intestinal tract. Other indicators are ammonium and other nitrogen compounds produced by decay.

Besides endangering our health and offending our senses, sewage pollution has another serious effect. In the process of decay, sewage uses up large quantities of dissolved oxygen. This oxygen not only is needed by fish and other organisms, but also kills bacteria and purifies the water.

Many industrial wastes likewise rob the water of its oxygen. Among these are the organic refuse from canneries, dairies, cheese factories, meat-packing houses and other food-processing plants. Wood fibre, bark and similar wastes

4 from pulp and paper mills produce the same effect.

On the bottom of a lake or stream, bark and other refuse may hinder fish from spawning.

Another cause of oxygen depletion is thermal pollution—the heating of large volumes of water. This occurs in many industrial processes, especially thermal-electric power production. Heat drives oxygen and other gases from the water, to the detriment of fish and other aquatic life.



THE GREEN MENACE

A serious problem is the many tons of phosphates, nitrates and other mineral salts now pouring into our major waterways. These stimulate the growth of algae and other vegetation—in many places a costly and offensive nuisance.

Phosphates are a basic ingredient of food refuse, human wastes, commercial fertilizers and household detergents. Nitrates are produced by the breakdown of human wastes and other organic matter. Phosphates, nitrates and other plant nutrients are also present in many industrial wastes. In our inland waters they nourish the algae.

Slimy masses of algae not only foul our beaches, but also clog our water intake pipes and filtration equipment. 5



They spoil our lakes and rivers for swimming, boating and other recreation. In some places—notably Lake Erie—they have seriously affected commercial fishing.

Lake Erie is suffering from an explosive growth of algae, spurred by the steady accumulation of phosphates and other nutrients. As the algae die they sink to the bottom and decay—thereby using up oxygen. With their oxygen content thus reduced, the deeper layers of water no longer support the more desirable types of fish.

Lake Erie formerly produced rich harvests of whitefish, ciscoe, walleye and blue pike. Today the catch consists largely of less valuable fish like smelt, perch and alewife.

The alewife, widely used in pet foods, has created a further pollution problem. The rotting corpses of these herring-like fish have littered miles of beaches and clogged water intakes. Moreover, the alewife uses up the food supplies of more valuable fish.

Along with many important fish species, many of the smaller creatures on which they feed are also disappearing. The May fly and caddis fly have vanished from deeper waters in western Lake Erie. Replacing them are sludge worms and
6 blood worms, which need less oxygen.

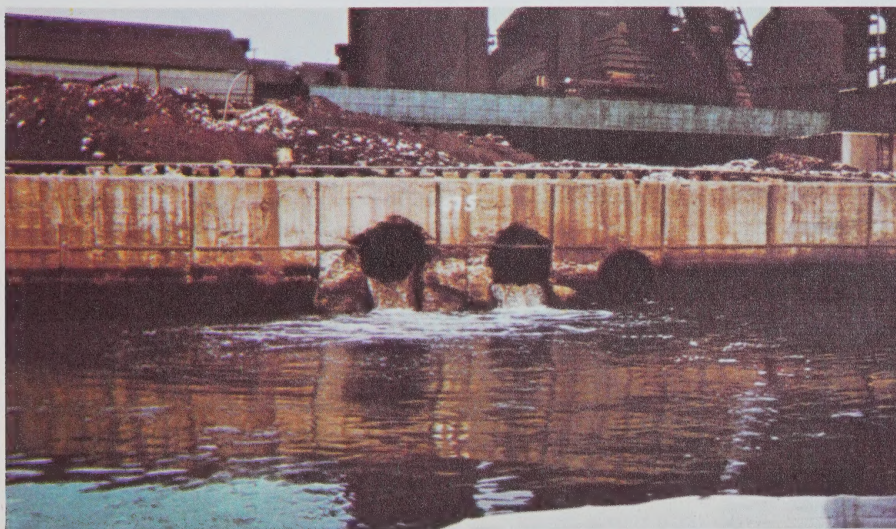
Elsewhere, in Lake Ontario's Toronto Harbor, sludge worms have been found to concentrate dangerous bacteria in their bodies.

POISONOUS WASTES

Many industrial wastes are poisonous to fish and other living things, including man. Among these wastes are cyanides, used in electroplating, hardening metal tools and extracting gold from its ore. Another such poison is arsenic, a by-product of roasting copper, lead and cobalt-silver ores. Arsenic is the basis of many pesticides.

Other polluting wastes include phenols, important in the manufacture of plastics, drugs, dyes and many other materials. They are also a by-product of the coking processes used in producing steel. In water, phenols cause unpleasant tastes and odors, tainting fish and sometimes killing them.

Oil not only spoils water for human use, but also kills fish and other aquatic life. It sticks to the feathers of water-fowl, destroying their natural water-proofing and insulation;



it also poisons them internally and clogs their breathing apparatus. Along the coasts of Newfoundland, many thousands of sea birds die each year because of oil pollution.

Widely used in industry is sulphuric acid. Besides harming fish, in strong concentrations it may also corrode metals and other materials. Sulphuric acid is often produced by the natural weathering of mining wastes or "tailings"—a troublesome source of pollution in some areas.

In turn, this acid may dissolve other metal-bearing minerals, causing further pollution by copper, lead or zinc. In some New Brunswick streams, for example, metallic pollution has killed fish and prevented salmon from spawning.

Agricultural pollution includes contamination by fertilizers and insecticides. Fertilizers contribute to the enrichment of our waters with food for algae—a process known technically as eutrophication. But while fertilizers help the algae, insecticides often destroy fish and wildlife.

These are just a few of the more important sources of water pollution. Their number grows each year with the development of new industrial chemicals and other materials. To eliminate them entirely would be impractical, if not impossible. But we must do our best to understand and control them.

WASTE TREATMENT

Sewage pollution can be largely eliminated by modern sewage treatment plants. These are the heavy artillery in our war on pollution and have sharply reduced health hazards in the Great Lakes and other parts of Canada. However, scientists and engineers are seeking ways to make them still more efficient.

In some communities sewage receives only primary treatment, which removes some of the solids by screening or settling. These solids are then decomposed by bacteria in sludge digester tanks, often assisted by aeration and recirculation.

With secondary treatment, bacteria and other micro-organisms are put to work further on the sewage. They then



consume most of the finer solids and dissolved organic matter left in the waste water after screening or settling.

One form of secondary treatment is the activated-sludge method, which mixes the partly treated sewage with bacteria-laden sludge. Another method is to spray the sewage onto trickling filters—beds of crushed stone which become coated with nitrifying bacteria and algae.

Many communities have outdoor sewage lagoons, where microorganisms do their work assisted by fresh air and sunlight. This natural purification is partly controlled by regulating the depth and flow of waste water.

Sewage treatment is most efficient when sanitary sewers are kept separate from storm sewers. Where a single sewage system carries both refuse and rainwater, a heavy storm may overload the treatment plant.

NOT SO SIMPLE

Industrial wastes are a more complicated problem, since many chemicals are unaffected by ordinary sewage treatment. Some can be recovered and re-used in the same plant—like the hydrochloric acid used in removing iron oxide from steel. Some can be used in other industries; chemical wastes from pulp and paper mills have been used to make alcohol and vanilla flavoring. Other wastes, however, may require special treatment.

Acid wastes are often neutralized by mixing them with lime or some other alkali. This is done, for example, in the lime-ponding of mining wastes. Radioactive materials may be buried deep in the earth, perhaps encased in some glassy substance to prevent their being dissolved by ground water.

How to dispose efficiently of these and other wastes is a major problem for scientists and engineers. They already have won some important victories on this battle front. Recently,



for example, they have developed special bacteria which feed on troublesome phenols. But many other riddles remain to be solved.

Detergents contain two different polluting substances—the foaming ingredient and the phosphate base. Today we can make detergents that will not spread unsightly foam on our lakes and rivers. But we still haven't found a way to eliminate the phosphates, an important cause of the algae nuisance in our waterways.

In older-type detergents the foaming ingredient will not break down under sewage treatment or other bacterial action. Newer detergents contain a different foaming substance which decomposes readily. To date, however, we have no practical substitute for the phosphates, which are largely unaffected by sewage treatment.

UNANSWERED QUESTIONS

This is just one of the vexing problems needing further research. To fight pollution effectively we need to know much more about it. How dangerous to health are various polluting substances, and what are their other effects? What new hazards are produced when harmless substances from different sources combine in our lakes and streams?

Since we can't stop pollution entirely, we want to know how much of it we can safely (and comfortably) live with. This would help us determine acceptable standards of water quality—essential in any realistic program of pollution control.

We still have much to learn about the many different causes of water pollution. Where does it come from? How does it spread? How does it circulate in large bodies of water like the Great Lakes? How long does pollution persist, and where does it finally go?

Searching for answers are scientists of the Department of Energy, Mines and Resources. Among them are chemists, physicists, geologists, hydrologists and oceanographers, closely assisted by mathematicians, engineers and other experts.

Main field headquarters in their war on pollution is at Burlington, Ontario, where the department is developing a 11



major water research centre—the Canada Centre for Inland Waters. There EMR scientists are probing all aspects of water pollution and ways of controlling it. Using special ships and modern shore facilities, they are turning the Great Lakes into a vast laboratory for pollution studies.

Working along with them are scientists from other departments and agencies, such as National Health and Welfare and the Fisheries Research Board. The Department of Energy, Mines and Resources coordinates the Canadian Government's water-research programs, as well as its other activities concerning water. It cooperates with provincial governments, the International Joint Commission and United States Government agencies concerned with pollution.

EMR is also developing a program of grants to universities for research on water resources, including pollution studies. The Department of National Health and Welfare offers similar grants for pollution research.

LEGAL WEAPONS

Canada's constitution gives the provinces jurisdiction
12 over water resources. But the Government of Canada also

has powers to make laws about water pollution. These are concerned with the pollution of fisheries, waterfowl habitat, boundary waters, navigable rivers and harbors.

Ottawa also gives technical advice to the provinces, which have wide powers of regulation and enforcement. Through grants to provincial health agencies, the Department of National Health and Welfare helps finance provincial programs of pollution control.

In addition, Ottawa provides financial aid in the construction of sewage treatment plants and other such facilities. For this purpose the Central Mortgage and Housing Corporation makes low-interest loans to municipalities, now totalling hundreds of millions of dollars. As a further encouragement, 25 per cent of these loans will be forgiven upon completion of the work. Other federal funds are contributed under the Winter Works Program.

Special provisions in federal income-tax regulations are designed to help companies install up-to-date facilities for treating their own wastes. These regulations provide for a two-year write-off of the capital cost of these installations.

But the federal government's most vital role in the war against water pollution is in providing leadership. The Minister of Energy, Mines and Resources is a member of the Canadian Council of Resource Ministers, which sponsored Canada's first national pollution conference in 1966. And today EMR scientists are playing a major part in developing guidelines for effective pollution control.

No government, though, can win the battle alone. No effort to control water pollution can succeed without the active support of industry, labor, professional people and the whole Canadian public.



YOUR PART IN THE BATTLE

1. Learn the facts about water pollution in your area, and what is being done about it.
2. Support laws and by-laws to control pollution.
3. Support the construction of adequate sewage treatment facilities.
4. Encourage local industries in their efforts to clean up their own wastes.
5. Get behind conservation groups and other organizations in their fight against pollution.

**DEPARTMENT OF ENERGY,
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ROGER DUHAMEL, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, 1967

Cat. No.: M22-3167